

THE 'CARRYING ANGLE' IN MAN

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Potter (1895) was the first to carry out a quantitative investigation on the obliquity between the upper arm and the fully extended and supinated forearm in man. He measured this 'carrying angle' in ninety-five men and ninety women and recorded average measurements of 173.17° and 167.35° respectively; that is to say the forearm was laterally inclined on the upper arm 6.83° in males and 12.65° in females. His measurements were carried out on the living by means of a hinged board 'applied to the limb', and also by dropping a plumb-line from the 'front and mid-line of the upper arm, the string touching the lesser tuberosity and allowed to fall exactly in the centre of the elbow'; he measured the distance between this line and the tendon of palmaris longus and derived a value for the carrying angle by elementary trigonometry. Subsequent measurements by essentially similar methods by Mall (1905), Nagel (1907) and Fick (1911) have all shown the mean female angle to be significantly greater than that of the male, though none reported a difference as great as the 5.82° recorded by Potter. In 1945, Atkinson & Elftman reported a difference between the male and female means of 1.8° , which they say is statistically significant but associated with too wide a variation to be of value in individual instances.

In order to eliminate differences due to variations in the development in the soft tissues in the arms of the two sexes it was decided to describe the vertex and arms of the carrying angle in terms of bony points, and it has been provisionally re-defined by the present authors as the acute angle lying between the tangent to the medial side of the head of the humerus produced through the tip of the medial epicondyle, and a line joining the tip of the epicondyle with the medial side of the lower end of the ulna. The tip of the epicondyle and the lower end of the ulna are points that may easily be palpated subcutaneously.

MATERIAL AND METHODS

The above subcutaneous bony points were marked with a pointer on a sheet of cardboard placed beneath the arm, the subject lying supine on the table of an X-ray machine with the forearm extended and supinated. The humeral head was then X-rayed (the plate being attached with drawing pins to the card) by means of the vertical component of a coned beam, the tube being aligned on the palpated medial

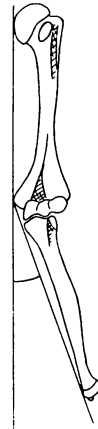


Fig. 1. Diagram illustrating 'carrying angle' defined in terms of bony points.

border of the humeral head by means of a plumb-line. The developed film having been re-pinned in its original position the two lines forming the angle were drawn on the card and the angle itself measured.

To check the accuracy of this method the angle was measured in a fresh cadaver, the body being raised into a sitting position and the arm circumducted between exposures. Four consecutive measurements gave angles of 22°, 23°, 23° and 23°.

The investigation was concerned with the left arms only of 100 Europiform adults (fifty of each sex) from staff and students of the London Hospital and Medical College. It was considered undesirable to subject any one person to more than a single X-ray exposure.

Table 1. 'Carrying angle'

	Males	Females
Mean	19.28°	18.38°
S.D.	4.67°	3.41°
Diff. of means	0.90°	
S.D. of diff.	0.82°	
Mean age (years)	23.26	21.06
Range (years)	18-40	19-30

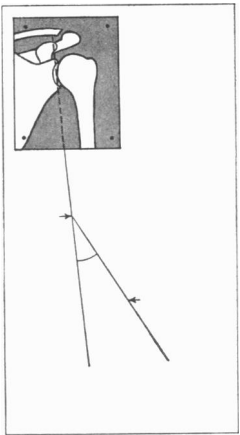


Fig. 2. Developed film re-pinned to card and 'carrying angle' drawn.

Since the carrying angle is in part due to the more distal position of the tip of the medial lip of the trochlea the 'trochlear angle' was measured in fifty dis-articulated adult humeri of known sex. The acute angle between (a) the tangent to the head of the humerus passing through the medial epicondyle, and (b) the line joining the distal parts of the lips of the trochlea, was recorded.

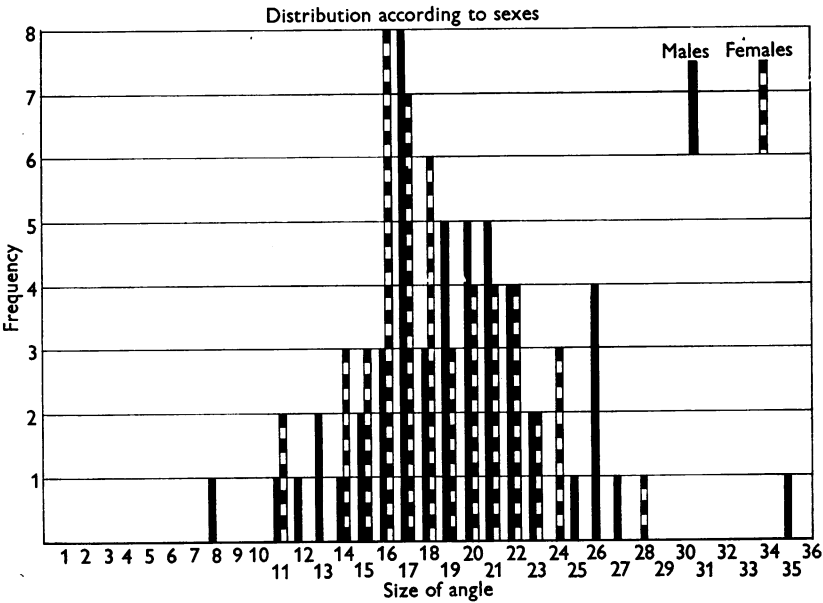


Fig. 3. Frequency histogram for the 'carrying angle'.

Table 2. 'Trochlear angle'

	Males	Females
Mean	73.5°	74.5°
S.D.	4.21°	2.95°
Diff. of means		1.0°
S.D. of diff.		1.03°

For neither the 'carrying angle' nor the 'trochlear angle' can the difference between the two groups be said to be statistically significant.

In order to find out to what extent the tangent to the head through the tip of the epicondyle is inclined to the long axis of the humerus, the latter has been provisionally defined as a line joining the mid-points of the coronal diameters of the bone at the junctions of the middle half with the upper and lower quarters. The angle between these two lines was measured in ten adult humeri and found never to exceed one degree.

Measurements of the carrying angle made by a method previously reported (Steel, 1957) on twenty adult dis-articulated human arm bones gave male and female means of 19.2° and 18.3° respectively. In view of the small sample and insignificant difference between these male and female means the authors conclude that the extremely close correlation between these figures and those obtained from living subjects is a chance finding.

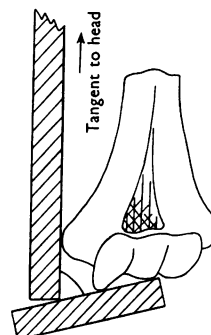


Fig. 4. Measurement of 'trochlear angle'.

SUMMARY

The human 'carrying angle' defined and measured as above appears as the parameter of a normal distribution curve.

Neither the 'carrying angle' nor the 'trochlear angle' exhibits any statistically significant difference in size between the two sexes.

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